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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/670,145	09/23/2003	Ellis Lee	TKHR6110-D1	7337
7590	06/15/2004		EXAMINER	
J.C. PATENTS Suite 250 4 Venture Irvine, CA 92618			LEE, HSIEN MING	
			ART UNIT	PAPER NUMBER
			2823	

DATE MAILED: 06/15/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.		Applicant(s)	
	10/670,145		LEE ET AL.	
	Examiner		Art Unit	
	Hsien-Ming Lee		2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 17-32, 72, 73 and 75 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 17-32, 72, 73 and 75 is/are rejected.
- 7) ☒ Claim(s) 25 is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 9/23/03 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
 Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
 Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. ____. |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date ____. | 6) <input type="checkbox"/> Other: ____. |

Hsien-Ming Lee 6/12/04

DETAILED ACTION

Remarks

1. Applicants' cancellation to claims 1-16, 33-71 and 74 is acknowledged. Thus, claims 17-32, 72-73 and 75 are pending in the application.

Drawings

2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference character(s) not mentioned in the description: "112a" and "100" (Fig.1), "212a" (Fig.2E) and "312a" (Fig.3).

Corrected drawing sheets, or amendment to the specification to add the reference character(s) in the description, are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.84(c)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Objections

3. Claim 25 is objected to because of the following informalities: at line 3, replacing "carbide and aluminum silicide" with -- carbide **or** aluminum silicide -- is suggested. See M.P.E.P. 2173.05(h), I. Appropriate correction is required.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 17-26, 28-32, 72 and 75 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. (US 6,492,732) in view of Lou (US 6,277,732).

In re claims 17-18, Lee et al. in Figs. 6A-6D and related text, teach the claimed semiconductor interconnect structure, comprising:

- a conductive structure 54 (i.e. aluminum, copper, tungsten, polysilicon, metal and metal alloy, col. 4, lines 53-55) having a top surface and a side surface;
- a liner layer 56 over the conductive structure 54, wherein the side surface of the conductive structure is surrounded by first level air gaps 100 and an upper portion of the side surface is surrounded by the liner layer 56 (Fig.6C);
- an etching stop layer 60/62 over the liner layer 56, wherein the etching stop layer 60/62 is disposed over the first level air gaps 100 (Fig.6C); and
- an opening 66 disposed over the top surface and part of the upper portion of the side surface of the conductive structure 54, wherein the first level air gaps 100 are isolated from the opening by the etching stop layer 60-62 (Fig.6D).

Lee et al. do not expressly teach that the liner layer 56 is a dielectric material. However, it would have been obvious to one of the ordinary skill in the art, at the time of the invention was made, to appreciate that the liner layer 56 has to be a dielectric material since without the

presence of the dielectric material the adjacent conductive structure would be shorted. In fact, using dielectric as liner layer to protect the underlying conductive structure has been widely used in the art, as evidenced by Lou in Fig. 1D, wherein a liner layer 206b (a silicon oxide, which is formed by PECVD, col. 3, lines 11-16) covers the conductive structure 202a~202c.

In re claims 19-22 and 24, the selection of the material for the dielectric layer and the etching stop layer is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. In re Jones, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and In re Boesch, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious). For example, one of the ordinary skill in the art would have motivated to select desired materials for the dielectric layer and the etching stop layer with different etch selectivity to ensure the formation of the opening without compromising the integrity of the underlying conductive structure.

In re claims 23 and 26, PECVD has been used in forming the dielectric materials, as evidenced by Lou, as stated above.

In re claim 25, Lee et al. teach that the etching stop layer can be silicon carbide, aluminum oxide or aluminum nitride (col. 5, lines 55-56).

In re claims 28-29, Lee et al. also teach a second dielectric layer 64 (i.e. oxide) disposed over the first dielectric layer 56 and the etching stop layer 60/62, wherein the opening 66 exposes the conductive structure 54 through the first dielectric layer 56 and the second dielectric layer 64 (Fig. 6D).

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In re claim 30, Lee et al. further teach that the level of the top surface of the conductive structure 54 is higher than a level of an interface between the first level air gaps 100 and the first dielectric layer 56 corresponding to a level between the conductive structure and the substrate 52/50 (Fig.6D).

In re claim 31, Lee et al. also teach that a height of an interface between the first level air gaps 100 and the substrate 52/50 is lower than a height of an interface between the conductive structure 54 and the substrate 52/50 (Fig. 6D).

In re claim 32, Lee et al. also demonstrated that the width of the opening 66 is substantially equal to the width of the conductive structure 54, as illustrated in Fig. 6D.

In re claims 72 and 75, Lee et al., in Fig.6D, further teach a substrate 52/50; a pair of conductive structures 54, wherein an air gap 100 disposed between the conductive structures 100; and a dielectric layer 56 over the conductive structures 54, the dielectric layer 56 having a stop layer 60/62 disposed over the air gap 100, wherein the dielectric layer 56 has an opening 66 disposed over at least a portion of the conductive structure 54 and at least a top portion of the stop layer 60/62, the opening 66 being isolated from the air gap 100.

6. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. in view of Lou as applied to claim 17 above, and further in view of Spallek et al. (US 6,123,991).

Lee et al. in view of Lou do not teach using PICVD for forming the etching stop, which is a dielectric material. However, using PICVD or PECVD for forming dielectric material has been used in the art, as evidenced by Spallek et al. (col. 2, lines 27-31).

Therefore, it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to use PICVD as taught by Spallek et al. in Lee et al. in view of Lou,

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since PICVD is an art recognized technique equivalent to PECVD and would provide an uniform coating (col. 3, lines 1-4, Spallek et al.)

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 571-272-1863. The examiner can normally be reached on M-F (9:00 ~ 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 571-272-1855. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Hsien-Ming Lee
Primary Examiner
Art Unit 2823

June 12, 2004

Hsien Ming Lee 6/12/04